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THE NEW FILTRATION PLANT AT QUINCY, ILLINOIS[1]

By W. R. Gelston

On the first day of September, 1914, one of the oldest mechanical filter plants in the United States was abandoned and a complete modern purification system was placed in operation at Quincy, Illinois, to take its place.

The old plant was built about the year 1891 under the O. H. Jewell patents and consisted of a stone masonry sedimentation basin 70 feet by 70 feet in area and 9 feet deep and 14 wooden tank filters 12 feet in diameter. There was also a small clear well under the filter tanks. This plant provided a sedimentation period of about one hour and the capacity of the filters was about 4,000,000 gallons per day under the usual rating for mechanical filters.

The new plant is of reinforced concrete with brick superstructure, steel doors and windows and it is absolutely fireproof. Three thousand yards of solid rock were excavated to prepare the site for the foundation and the entire plant rests upon solid rock. The east wall is also backed up by a solid limestone ledge which rises from 12 to 15 feet above the basin floors.

The concrete structure is 172 feet by 89 feet and the highest concrete walls rise 25 feet above the footings. Of the total area, the six 1,000,000 gallon filter units, with the pipe gallery, cover 40 feet by 89 feet at the north end. Adjoining the filters on the south, a space 12 feet by 89 feet is used for the main entrance and stairways leading down to the pipe gallery and up to the operating floor, and for the steam heating plant and coal bin. Then a space 24 feet by 89 feet is occupied by the forebays and mixing chambers. The remaining area, 96 feet by 89 feet, is used for sedimentation purposes.

Two complete coagulating, mixing, and sedimentation units are provided and connected in such a manner that they can be operated in parallel, in series, or either unit may be operated alone. They are of unequal capacity. The No. 1 unit provides for two-thirds of the total capacity and the No. 2 unit one-third.

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[1] Read at meeting of Illinois Section, American Water Works Asssociation, March 10, 1915.

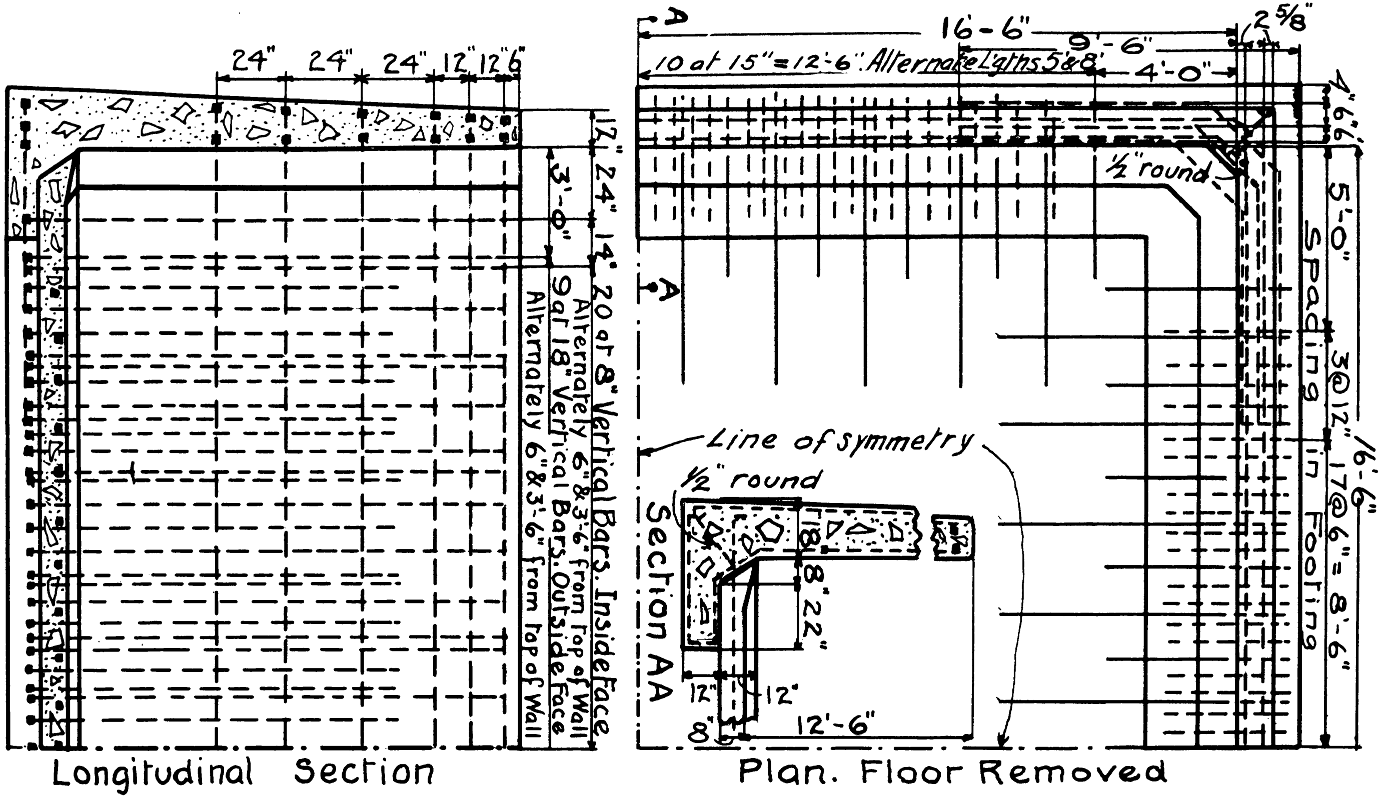
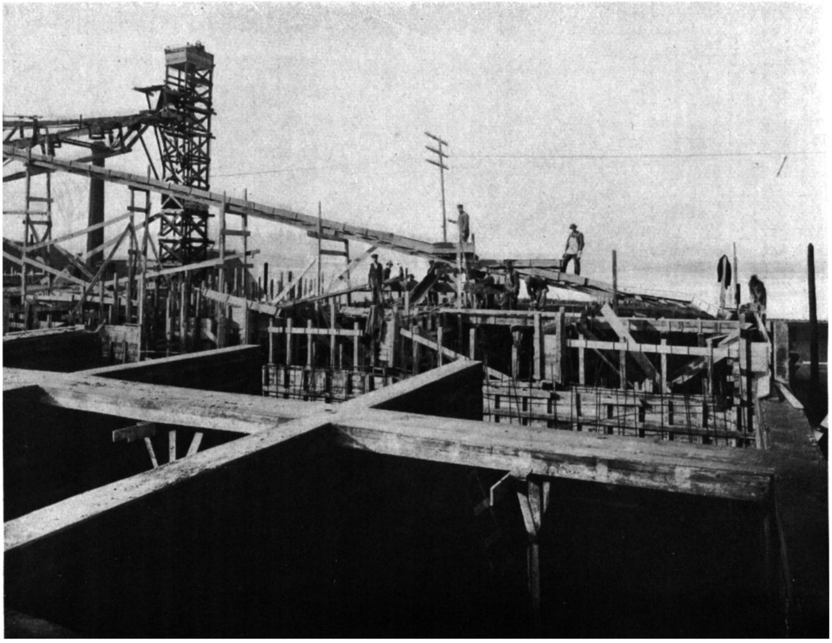


FIG. 1. DETAILS OF REINFORCEMENT OF WASH WATER RESERVOIR. ALL BARS $\frac{1}{2}$ INCH SQUARE, TWISTED, OR EQUIVALENT, UNLESS NOTED

The short experience with this plant leads to the belief that the best results can be obtained by the series method of operating. The plant is therefore being operated as follows:

The low service pumps discharge into an open forebay where the water is treated with the first dose of sulphate of alumina. It then travels about 400 feet over and under the concrete baffles in the mixing chambers and finally passes through sluice gates into sedimentation basin No. 2. This basin is 27 feet by 94 feet by 20 feet in depth and is provided with a vertical concrete baffle which extends nearly the entire length of the basin on the center line. When the plant is operating at a six million gallon rate this basin provides a travel of about 175 feet and a period of one and one-half hours for sedimentation. From the outlet side of this basin the water is drawn from the surface, over a weir, through a large sluice gate, and passes through a concrete flume to the second forebay where it receives its second dose of alum, as it begins its tortuous passage through the mixing chambers connected with Basin No. 1.



Filter Plant During Construction

This basin is 55 feet by 94 feet by 20 feet deep with one vertical concrete baffle on the center line around which the water must pass. The sedimentation period in this basin is about three hours, making the total for both basins, four and one-half hours. The water passes from the outlet side of this basin to the filters.

Steel storage tanks, for coagulating solutions, are provided in duplicate for the alum and lime. A small electric motor is used to stir the solutions constantly to keep them of uniform strength.

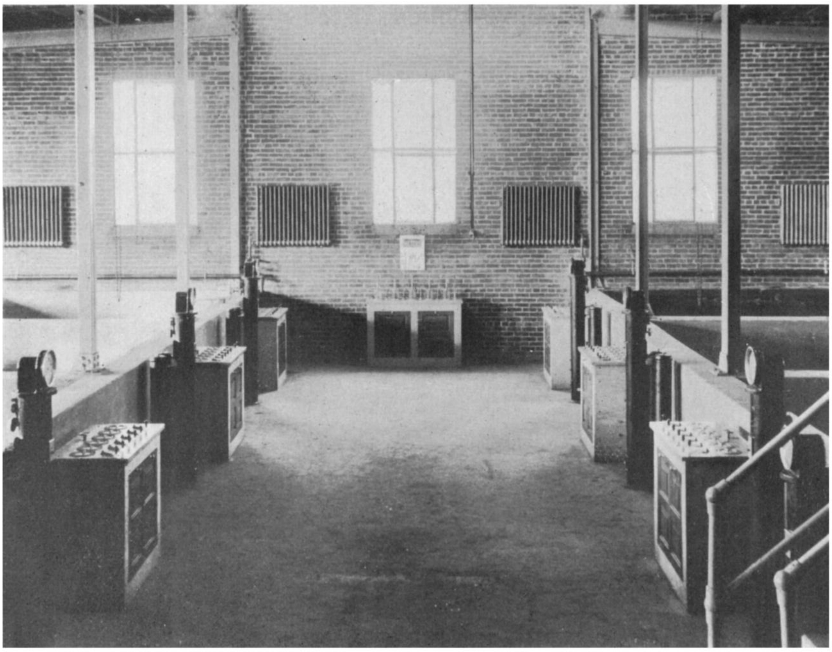
HEAD HOUSE

The coagulant feed is accomplished by means of constant head orifice boxes, the solution flowing by gravity from the orifice boxes to the forebays.

A complete hypochlorite sterilizing plant is also installed in duplicate. This solution flows by gravity and it is introduced into the filtered water as it passes through a 24-inch pipe line on its way to the high service pumps.

The six filters are grouped, three on each side of the pipe gallery.

They have a sand area 12 feet by 32 feet and they are 10 feet deep. The regulation strainer system, as designed for the combined air and water wash, is used. The strainers are covered to a depth of one foot with graded gravel and the sand has a depth of 30 inches. Ottawa sand of 0.38 of a millimeter effective size is used. Two steel wash water troughs run the entire length of the filters and provide a very uniform flow of water from the entire sand area during the washing process.



Operating Floor

The filters are equipped with loss of head gauges, hydraulic operated valves and the Venturi tube type of rate controllers. The space under the filter beds is used for storage of filtered water. The two basins 32 feet by 38 feet each in area and holding a depth of water of 9 feet provide storage capacity for 160,000 gallons. Since water for filter washing is taken from the clear wells the capacity is rather small and it would be entirely inadequate if direct pressure were maintained. Duplicate motor driven centrifugal pumps and one motor driven blower comprise the necessary mechanical equipment for filter washing.

The brick superstructure is of handsome design. A buff colored St. Louis hydraulic pressed brick with a dark red brick for quoins and Bedford stone trim comprise an exterior of pleasing as well as substantial appearance.

The head house, which is 62 feet by 89 feet and two stories in height, is located over the forebays, mixing chambers and a part of the sedimentation basins. The second floor is of reinforced concrete supported by concrete columns and beams. This floor provides ample space for the storage and mixing of coagulants. The tops of the solution tanks extend 3 feet above the second floor and they rest upon concrete platforms which stand 5 feet above the lower floor. Numerous manhole frames and covers, set in the floor, provide access for cleaning and opportunity for study of the effect of the coagulants on the water as it passes through the mixing

Mixing Chambers

chambers. Large rectangular openings, over the inlet and outlet of the sedimentation basins also provide convenient points for sampling and observation of the operating results.

A well-equipped water works laboratory is also located on this floor. It consists of four connecting rooms having a total floor area of 625 square feet, with well lighted work benches and sinks, and all of the apparatus and utensils necessary for the preparation of media and for the bacterial and microscopic examination of water.

The filters are covered by a one-story brick superstructure which rests upon the outside walls of the filters, leaving the entire area of the filter beds open for inspection. This room is well lighted by means of a monitor roof over the operating floor in addition to the windows in the side walls.

DISCUSSION

MR. W. F. LANGELIER: The official test of the Quincy plant was completed March 1, but inasmuch as the report has not yet been submitted, the speaker wishes to withhold from discussion the results obtained, inasfar as the various guarantees are concerned. One or two unusual operating features, however, were observed and a discussion of them might be interesting to some of the members present.

It was noted that during December the filter runs, or intervals between filter washings, had become materially reduced, and for a few days averaged less than five hours. At this time the turbidity in the raw water was at a minimum and remained constant at 20 parts per million. The experience was similar to one noted during the test of the Evansville, Indiana, plant in 1912 at which time the trouble was ascribed to clogging of the sand by micro-organisms. At Quincy, however, microscopical examinations indicated only small numbers of organisms and moreover the settling basins were quite efficient in removing them. The number and size of the organisms passing to the filters daily was sufficiently small to make absurd the probability that they were directly clogging the filters.

Further investigation showed that the raw water was approximately 100 per cent supersaturated with dissolved oxygen and that the shorter runs were due to gas released in the gravel and underdrain system, probably as a result of the reduced or negative pressure caused by the sealed down draft. In this manner it is possible to account theoretically for a very considerable volume of gas being released. The extent to which the length of runs may be affected, however, may depend on certain features of filter design by virtue of which the liberated gas is largely made to discharge with the effluent. The further disadvantages of air binding such as the possibility of gravel displacement are well known.

Excess oxygen in both rivers and lakes is a very common occurrence and in all probability much of the trouble being experienced in other filter plants by short runs and attributed to clogging by micro-organisms, is due to this same cause.

In addition to the fact that the raw water was only slightly turbid it was noted that it reacted pink to phenolphthalein indicating an absence of free carbon dioxide and suggesting photosynthesis as the cause of supersaturation. The trouble which lasted somewhat over a week disappeared as soon as the river became coated with ice and snow.

Another feature during the test, which was interesting to us, was the cause of an apparent reduction in the efficiency of the sedimentation basins. The average reduction of bacteria in the settling basins was equal to approximately 85 per cent. During the early part of February this efficiency began to decrease and for about a week a removal of 65 per cent was the best that could be accomplished. This reduced efficiency greatly increased the burden of the filters and it was evident that something had to be done if the guaranteed 97 per cent total removal was to be maintained. The basins had been cleaned only a short time previously and soundings showed that there was only an average depth of a few inches of sludge. There had been no change in the character of the raw water and there seemed to be no good reason for increasing the coagulant dose. It was finally decided to clean the sedimentation basin again, but before this was done several temperature readings were taken. Due to the season of the year it was found that the temperature variations were quite wide. The ice had just left the river a day or two before and much milder atmospheric temperatures were being recorded. The water admitted to the basins was in the neighborhood of 38° but after standing quiet in the basins over night the upper strata continued to rise in temperature. Thus, due to the increased density, a slight overturning, causing some disturbance of the sludge, occurred, and it was believed that this was responsible for the decreased bacterial efficiency. The basins were cleaned and, as predicted, the average efficiency returned to the normal of 85 per cent.

Mr. H. E. Babbitt: In answer to Mr. Langelier's discussion, the writer would like to ask whether there is any reason for suggesting the supersaturation of the water with oxygen. The most common reason advanced for supersaturation of water is the presence of some of the chlorophycae group, which organism possesses the property of giving off large quantities of oxygen, which is retained by the water. In examination of Des Plains River as much as 300 per cent saturation has been found, with visible indications of chlorophycae. In his description of his microscopic examination, Mr. Langelier did not mention the presence of an organism of this group. These organisms exist best in quiet water with relatively high temperatures. Violent agitation causes the precipitation of the oxygen. It is interesting to note that the mixing action in the reaction chamber was insufficient to cause the liberation of the oxygen, and that the reduced pressure in the negative head filter is sufficient to affect it. Practically all so-called "positive head" filters have some "negative head" at times, which might cause the troubles explained by Mr. Langelier.